

CLAIMS

1           1. A laser and optical amplifier device comprising:

2           a waveguide having a plurality of layers of semiconductor material with different  
3 optical indices, the waveguide including a first heightened region in a first of said layers, the  
4 first heightened region forming a channel along a longitudinal axis within which a lowest order  
5 spatial mode in both lateral and transverse directions is supported;

6           an active region within a second layer near the first heightened region of the waveguide  
7 that is pumped to provide gain for said lowest order spatial mode in said waveguide; and

8           first and second lateral regions, extending parallel to and on each side of said first  
9 heightened region along the longitudinal axis, into which all higher order spatial modes extend  
10 laterally and are suppressed, wherein the cross-sectional dimensions of the lowest order spatial  
11 mode are at least several times larger in both the transverse and lateral directions than the  
12 optical wavelength inside the dielectric medium of the waveguide.

1           2. The device of claim 1 further comprising second and third heightened regions,  
2 which extend parallel to and are separated from said first heightened region along the  
3 longitudinal axis, and include absorptive regions to provide loss for higher order spatial modes.

1           3. The device of claim 1, wherein loss in said first and second lateral regions is  
2 generated by bombardment of all or certain layers with protons or other damage-inducing ions  
3 to provide additional loss for higher order spatial modes.

1           4. The device of claim 1, wherein loss in said first and second lateral regions is

2 generated by roughening the sidewalls of the device to further suppress higher order spatial  
3 modes.

1 5. The device of claim 1, wherein loss in said first and second lateral regions is  
2 generated by doping said regions to provide large free-carrier absorption which adds additional  
3 loss for higher order spatial modes.

1 6. The device of claim 1, wherein the cross-sectional dimensions of the lowest order  
2 spatial mode are at least an order of magnitude larger than the optical wavelength inside the  
3 dielectric medium of the waveguide.

1 7. The device of claim 2, wherein the cross-sectional dimensions of the lowest order  
2 spatial mode are at least an order of magnitude larger than the optical wavelength inside the  
3 dielectric medium of the waveguide.

1 8. The device of claim 1, wherein the contours of constant optical intensity for the  
2 lowest order spatial mode supported within said waveguide are nearly circular.

1 9. The device of claim 1, wherein the contours of constant optical intensity for the  
2 lowest order spatial mode supported within said waveguide have an approximately elliptical  
3 shape with a small aspect ratio.

1 10. The device of claim 2, wherein the contours of constant optical intensity for the  
2 lowest order spatial mode supported within said waveguide are nearly circular.

1 11. The device of claim 2, wherein the contours of constant optical intensity for the

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lowest order spatial mode supported within said waveguide have an approximately elliptical shape with a small aspect ratio.

12. The device of claim 2, wherein the first heightened region in the waveguide is defined by a region between two parallel etched channels in said layers, and wherein said second and third heightened regions are positioned outside the two parallel etched channels.

13. A laser and optical amplifier device comprising:  
a dielectric structure having a waveguide defined therein which supports only a lowest order spatial mode of propagation, the lowest order mode having a wavelength inside the dielectric medium of the waveguide at least an order of magnitude smaller than a cross-sectional dimension of said waveguide, and in which higher order spatial modes extend laterally and are suppressed; and  
a quantum well region formed in parallel and adjacent to the waveguide that generates light that is confined to a lowest order mode of propagation by the waveguide.

14. The device of claim 13, wherein the contours of constant optical intensity for the lowest order spatial mode supported within said waveguide are nearly circular.

15. The device of claim 13, wherein the contours of constant optical intensity for the lowest order spatial mode supported within said waveguide have an approximately elliptical shape with a small aspect ratio.

16. The device of claim 13, wherein the dielectric structure is a layer in a semiconductor device.

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1 17. The device of claim 13, wherein said waveguide is defined along a longitudinal  
2 axis by a region between two parallel etched channels in the dielectric structure.

1 18. The device of claim 17, wherein regions in the dielectric structure outside the two  
2 parallel etched channels along the longitudinal axis suppress high order modes.

1 19. A slab coupled optical waveguide laser comprising:  
2 a waveguide having a plurality of layers of semiconductor material with different  
3 optical indices, the waveguide including a first heightened region in a first of said layers, the  
4 first heightened region forming a channel along a longitudinal axis within which a longitudinal  
5 lowest order spatial mode in both lateral and transverse directions is supported;  
6 an active region within a second layer near the first heightened region of the waveguide  
7 that is pumped to provide gain for said lowest order spatial mode in said waveguide; and  
8 first and second lateral regions, extending parallel to and on each side of said first  
9 heightened region along the longitudinal axis, into which all higher order spatial modes extend  
10 laterally and are suppressed.

1 20. A slab coupled optical waveguide laser comprising:  
2 a dielectric structure having a waveguide defined therein which supports a lowest order spatial  
3 mode of propagation, the lowest order mode having a wavelength inside the dielectric medium  
4 of the waveguide at least an order of magnitude smaller than a cross-sectional dimension of  
5 said waveguide, and in which higher order spatial modes extend laterally and are suppressed;  
6 and

7 a quantum well region formed in parallel and adjacent to the waveguide that generates  
8 light that is confined to a lowest order mode of propagation by the waveguide.

1 21. A laser and optical amplifier device comprising:

2 a dielectric structure having a waveguide defined therein which supports a lowest order  
3 spatial mode of propagation, the lowest order mode having a wavelength inside the dielectric  
4 medium of the waveguide at least several times smaller in both transverse directions than a  
5 cross-sectional dimension of said waveguide, and in which higher order spatial modes extend  
6 laterally and are suppressed; and

7 a quantum well region formed in parallel and adjacent to the waveguide that generates  
8 light that is confined to a lowest order mode of propagation by the waveguide.

1 22. The device of claim 21, wherein the contours of constant optical intensity for the  
2 lowest order spatial mode supported within said waveguide are nearly circular, having an  
3 approximately elliptical shape with a small aspect ratio.

1 23. The device of claim 21, wherein the dielectric structure is a layer in a  
2 semiconductor device.

1 24. The device of claim 21, wherein said waveguide is defined along a longitudinal  
2 axis by a region between two parallel etched channels in the dielectric structure.

1 25. The device of claim 24, wherein regions in the dielectric structure outside the two  
2 parallel etched channels along the longitudinal axis suppress high order modes.

26. A slab coupled optical waveguide laser amplifier device comprising:  
 a dielectric structure having a waveguide defined therein which supports a lowest order spatial  
 mode of propagation, the lowest order mode having a wavelength inside the dielectric medium  
 of the waveguide at least several times smaller in both transverse directions than a cross-  
 sectional dimension of said waveguide; and  
 a quantum well region formed in parallel and adjacent to the waveguide that generates  
 light that is confined to a lowest order mode of propagation by the waveguide.

27. The device of claim 26, wherein the contours of constant optical intensity for the  
 lowest order spatial mode supported within said waveguide are nearly circular, having an  
 approximately elliptical shape with a small aspect ratio.

28. The device of claim 1, wherein a quantum well region provides gain.

29. The device of claim 1, wherein a quantum well region comprising one or more  
 quantum wells, barrier layers and bounding layers provides gain.

30. The device of claim 1, wherein a strained-layer quantum well region provides  
 gain.

31. The device of claim 1, wherein a strained-layer quantum well region comprising  
 one or more quantum wells, barrier layers and bounding layers provides gain.

32. The device of claim 1, wherein a region containing quantum dots or quantum wires  
 provides gain.

1           33. The device of claim 1 in which a region containing quantum dots or quantum wires  
2 inside one or more quantum well layers provides gain.

1           34. The device of claim 1, wherein gain is provided by a region containing one or  
2 more semiconductor layers.

1           35. The device of claim 2, wherein the regions between the first and second heightened  
2 regions and between the first and third heightened regions are filled with high resistivity  
3 material.

1           36. The device of claim 1, wherein plurality of layers of semiconductor material with  
2 different optical indices are made of III-V compound semiconductors.

1           37. The device of claim 1, wherein plurality of layers of semiconductor material with  
2 different optical indices are made in the  $\text{In}_x\text{Ga}_{1-x}\text{As}_y\text{P}_{1-y}$  semiconductor system on an InP  
3 substrate.

1           38. The device of claim 1, wherein plurality of layers of semiconductor material with  
2 different optical indices are made in the  $\text{Al}_x\text{Ga}_y\text{In}_{1-x-y}\text{As}$  semiconductor system on an InP  
3 substrate.

1           39. The device of claim 1, wherein plurality of layers of semiconductor material with  
2 different optical indices are made in a combination of the  $\text{Al}_x\text{Ga}_y\text{In}_{1-x-y}\text{As}$  and  $\text{In}_x\text{Ga}_{1-x}\text{As}_y\text{P}_{1-y}$   
3 semiconductor systems on an InP substrate.

1           40. The device of claim 1, wherein plurality of layers of semiconductor material with

2 different optical indices are made in the  $\text{Al}_x\text{Ga}_{1-x}\text{As}$  semiconductor system on a GaAs substrate.

1 41. The device of claim 1, wherein plurality of layers of semiconductor material with  
2 different optical indices are made in the  $\text{Al}_x\text{Ga}_y\text{In}_{1-x-y}\text{As}$  semiconductor system on a GaAs  
3 substrate.

1 42. The device of claim 1, wherein plurality of layers of semiconductor material with  
2 different optical indices are made in a combination of the  $\text{Al}_x\text{Ga}_{1-x}\text{As}_z$  and  $\text{In}_x\text{Ga}_{1-x}\text{As}$   
3 semiconductor systems on a GaAs substrate.

1 43. The device of claim 1, wherein plurality of layers of semiconductor material with  
2 different optical indices are made in a the  $\text{Ga}_y\text{In}_{1-y}\text{As}_z\text{P}_{1-z}$  semiconductor systems on a GaAs  
3 substrate.

1 44. The device of claim 1, wherein plurality of layers of semiconductor material with  
2 different optical indices are made in a the  $\text{Al}_x\text{Ga}_y\text{In}_{1-x-y}\text{As}_z\text{P}_{1-z}$  semiconductor systems on a  
3 GaAs substrate.

1 45. The device of claim 1, wherein plurality of layers of semiconductor material with  
2 different optical indices are made in a combination of the  $\text{Al}_x\text{Ga}_y\text{In}_{1-x-y}\text{As}_z\text{P}_{1-z}$  and  
3  $\text{In}_x\text{Ga}_{1-x}\text{As}_y\text{P}_{1-y}$  semiconductor systems on a GaAs substrate.

1 46. The device of claim 1, wherein plurality of layers of semiconductor material with  
2 different optical indices are made in the  $\text{Al}_x\text{Ga}_y\text{In}_{1-x-y}\text{As}_z\text{Sb}_{1-z}$  semiconductor system on an InP  
3 substrate.



1 47. The device of claim 1, wherein plurality of layers of semiconductor material with  
2 different optical indices are made in a combination of the  $Al_xGa_yIn_{1-x-y}As_zSb_{1-z}$  and  $In_xGa_{1-x}$   
3  $As_yP_{1-y}$  semiconductor systems on an InP substrate.

1 48. The device of claim 1, wherein plurality of layers of semiconductor material with  
2 different optical indices are made in the  $Al_xGa_yIn_{1-x-y}As_zSb_{1-z}$  semiconductor system on a GaSb  
3 substrate.

1 49. The device of claim 1, wherein plurality of layers of semiconductor material with  
2 different optical indices are made in the  $Al_xGa_yIn_{1-x-y}As_zSb_{1-z}$  semiconductor system on an InAs  
3 substrate.

1 50. The device of claim 1, wherein plurality of layers of semiconductor material with  
2 different optical indices are made in the  $Al_xGa_yIn_{1-x-y}N$  semiconductor system on a GaN  
3 substrate.

1 51. The device of claim 1, wherein plurality of layers of semiconductor material with  
2 different optical indices are made in the  $Al_xGa_yIn_{1-x-y}N$  semiconductor system on a sapphire  
3 substrate.

1 52. The device of claim 1, wherein plurality of layers of semiconductor material with  
2 different optical indices are made in the  $Al_xGa_yIn_{1-x-y}N$  semiconductor system on a SiC  
3 substrate.

1 53. The device of claim 1, wherein plurality of layers of semiconductor material with

2 different optical indices are made in a the  $Al_xGa_yIn_{1-x-y}As_zN_{1-z}$  semiconductor systems on a  
3 GaAs substrate.

1 54. The device of claim 1 wherein plurality of layers of semiconductor material with  
2 different optical indices are made of II-VI compound semiconductors.

1 55. The device of claim 1 wherein plurality of layers of semiconductor material with  
2 different optical indices are made of IV-VI compound semiconductors.